

CRC Handbook of Chemistry and Physics

A Ready-Reference Book of Chemical and Physical Data



Editor-in-Chief

David R. Lide, Ph.D.

Former Director, Standard Reference Data
National Institute of Standards and Technology

Associate Editor

H. P. R. Frederikse, Ph.D.

(Retired)
Ceramics Division
National Institute of Standards and Technology



CRC Press

Boca Raton Ann Arbor London Tokyo

BEST AVAILABLE COPY

BEST AVAILABLE COPY

© 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994 by CRC Press, Inc.

© 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973 by THE CHEMICAL RUBBER CO.
Copyright 1918, 1920 by The Chemical Rubber Company (Copyright renewed 1946, 1948 by The Chemical Rubber Publishing Company)

Copyright 1922 (Copyright renewed 1950), 1925 (Copyright renewed 1953), 1926 (Copyright renewed 1954), 1927 (Copyright renewed 1955), 1929 (Copyright renewed 1957), 1936, 1937 (Copyright renewed 1965 by The Chemical Rubber Co.), 1939, 1940 (Copyright renewed 1968 by the Chemical Rubber Co.), 1941 (Copyright renewed 1969 by The Chemical Rubber Co.), 1942 (Copyright renewed 1970 by The Chemical Rubber Co.), 1943 (Copyright renewed 1971 by The Chemical Rubber Co.), 1944 (Copyright renewed 1972 by The Chemical Rubber Co.), 1945 (Copyright renewed 1973 by The Chemical Rubber Co.), 1947, 1949, 1950, 1951, 1952 (Copyright renewed 1980 by CRC Press, Inc.), 1953 (Copyright renewed 1981a by CRC Press, Inc.), 1954 (Copyright renewed 1982 by CRC Press, Inc.), 1955 (Copyright renewed 1983 by CRC Press, Inc.), 1956 by Chemical Rubber Publishing Company

© 1957, 1958, 1959, 1960, 1962 by Chemical Rubber Publishing Company

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. A wide variety of references are listed. Reasonable efforts have been made to publish reliable data and information, but the author and the publisher cannot assume responsibility for the validity of all materials or for the consequences of their use.

Neither this book nor any part may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, microfilming, and recording, or by any information storage or retrieval system, without prior permission in writing from the publisher.

All rights reserved. Authorization to photocopy items for internal or personal use, or the personal or internal use of specific clients, may be granted by CRC Press, Inc., provided that \$.50 per page photocopied is paid directly to Copyright Clearance Center, 27 Congress Street, Salem, MA 01970 USA. The fee code for users of the Transactional Reporting Service is ISBN 0-8493-0475-X/94/\$0.00+.50. The fee is subject to change without notice. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

CRC Press, Inc.'s consent does not extend to copying for general distribution, for promotion, for creating new works, or for resale. Specific permission must be obtained in writing from CRC Press for such copying.

Direct all inquiries to CRC Press, Inc., 2000 Corporate Blvd., N.W., Boca Raton, Florida 33431.

© 1994 by CRC Press, Inc.

No claim to original U.S. Government works

International Standard Book Number 0-8493-0475-X

Library of Congress Card Number 13-11056

Printed in the United States of America 1 2 3 4 5 6 7 8 9 0

Printed on acid-free paper

ORGANIC RADICALS AND RING SYSTEMS (continued)

hydroperoxy	HOO-	phosphinyl	H,P(O)-
hydroxamino	HONH-	phospho	O,P-
hydroxy	HO-	phosphono	(HO),P(O)-
		phthalyl (from phthalic acid)	1,2-C ₆ H ₄ (CO-),
imino	HN=	picryl (2,4,6-trinitrophenyl)	2,4,6-(NO ₂) ₃ C ₆ H ₂ -
iodoso	OI-	pimelyl (from pimelic acid)	-OC(CH ₃) ₂ CO-
isoamyl (isopentyl)	(CH ₃) ₂ CH(CH ₂) ₂ -	piperidino	C ₄ H ₈ N-
isobutenyl (2-methyl-1-propenyl)	(CH ₃) ₂ C=CH-	piperidyl (piperidinyl)	(C ₄ H ₇ N)-
isobutoxy	(CH ₃) ₂ CHCH ₂ O-	piperonyl	3,4-(CH ₂ O) ₂ C ₆ H ₃ CH ₂ -
isobutyl	(CH ₃) ₂ CHCH ₂ -	pivalyl (from pivalic acid)	(CH ₃) ₃ CCO-
isobutylidene	(CH ₃) ₂ CHCH=	prenyl (3-methyl-2-butenyl)	(CH ₃) ₂ C=CHCH ₂ -
isobutyryl	(CH ₃) ₂ CHCO-	propargyl (2-propynyl)	HC≡CCH ₂ -
isocyanato	OCN-	propenyl	CH ₂ =CHCH ₂ -
isocyano	CN-	iso-propenyl	(CH ₃) ₂ C=
isohexyl	(CH ₃) ₂ CH(CH ₂) ₃ -	propionyl	CH ₃ CH ₂ CO-
isoleucyl (from isoleucine)	C ₆ H ₇ CH(CH ₃)CH(NH ₂)CO-	propoxy	CH ₃ CH ₂ CH ₂ O-
isonitroso	HON=	propyl	CH ₃ CH ₂ CH ₂ -
isopentyl	(CH ₃) ₂ CH(CH ₂) ₂ -	iso-propyl	(CH ₃) ₂ CH-
isopentylidene	(CH ₃) ₂ CHCH ₂ CH=	propylidene	CH ₃ CH ₂ CH=
isopropenyl	H ₂ C=C(CH ₃)-	pyridino	C ₅ H ₅ N-
isopropoxy	(CH ₃) ₂ CHO-	pyridyl (pyridinyl)	(C ₅ H ₄ N)-
isopropyl	(CH ₃) ₂ CH-	pyrryl (pyrrolyl)	(C ₄ H ₃ N)-
isopropylidene	(CH ₃) ₂ C=		
isothiocyanato (isothiocyano)	SCN-	salicyl (2-hydroxybenzoyl)	2-HOC ₆ H ₄ CO-
isovaleryl (from isovaleric acid)	(CH ₃) ₂ CHCH ₂ CO-	selenyl	HSe-
		seryl (from serine)	HOCH ₂ CH(NH ₂)CO-
		siloxo	H ₂ SiO-
keto (oxo)	O=	silyl	H ₃ Si-
		silylene	H ₂ Si=
lactyl (from lactic acid)	CH ₃ CH(OH)CO-	sorbyl (from sorbic acid)	CH ₃ CH=CHCH=CHCO-
lauroyl (from lauric acid)	CH ₃ (CH ₂) ₁₀ CO-	stearyl (from stearic acid)	CH ₃ (CH ₂) ₁₇ CO-
leucyl (from leucine)	(CH ₃) ₂ CHCH ₂ CH(NH ₂)CO-	styryl	C ₆ H ₅ CH=CH-
levuliny (From levulinic acid)	CH ₃ CO(CH ₂) ₂ CO-	suberyl (from suberic acid)	-OC(CH ₃) ₂ CO-
		succinamyl	H ₂ NCOCH ₂ CH ₂ CO-
malonyl (from malonic acid)	-OCCH ₂ CO-	succinyl (from succinic acid)	-OCCH ₂ CH ₂ CO-
mandelyl (from mandelic acid)	C ₆ H ₅ CH(OH)CO-	sulfamino	HOSO ₂ NH-
mercapto	HS-	sulfamyl	H ₂ NSO-
methacrylyl (from methacrylic acid)	CH ₂ =C(CH ₃)CO-	sulfanilyl	4-H ₂ NC ₆ H ₄ SO ₂ -
methallyl	CH ₂ =C(CH ₃)CH ₂ -	sulfeno	HOS-
methionyl (from methionine)	CH ₃ SCH ₂ CH ₂ CH(NH ₂)CO-	sulfinyl	HS-
methoxy	CH ₃ O-	sulfo	OS=
methyl	H ₃ C-	sulfonyl	HO ₂ S-
methylene	H ₂ C=		-SO ₂ -
methylenedioxy	-OCH ₂ O-	terephthalyl	1,4-C ₆ H ₄ (CO-),
methylenedisulfonyl	-O ₂ SCH ₂ SO ₂ -	tetramethylene	-(CH ₂) ₄ -
methylol	HOCH ₂ -	thenyl	(C ₆ H ₅ S)CH-
methylthio	CH ₃ S-	thienyl	(C ₄ H ₃ S)-
myristyl (from myristic acid)	CH ₃ (CH ₂) ₁₂ CO-	thiobenzoyl	C ₆ H ₅ CS-
naphthal	(C ₁₀ H ₇)CH=	thiocarbamyl	H ₂ NCS-
naphthobenzyl	(C ₁₀ H ₇)CH ₂ -	thiocarbonyl	-CS-
naphthoxy	(C ₁₀ H ₇)O-	thiocarboxy	HOSC-
naphthyl	(C ₁₀ H ₇)-	thiocyanato	NCS-
naphthylidene	(C ₁₀ H ₇)=	thionyl (sulfinyl)	-SO-
neopentyl	(CH ₃) ₃ CCH ₂ -	thiophenacyl	C ₆ H ₄ CSCH ₂ -
nitramino	O ₂ NNH-	thiuram (aminothioxomethyl)	H ₂ NCS-
nitro	O ₂ N-	threonyl (from threonine)	CH ₃ CH(OH)CH(NH ₂)CO-
nitrosamino	ONNH-	toluidino	CH ₃ C ₆ H ₄ NH-
nitrosimino	ONN=	toluyl	CH ₃ C ₆ H ₄ CO-
nitroso	ON-	tolyl (methylphenyl)	CH ₃ C ₆ H ₄ -
nonanoyl (from nonanoic acid)	CH ₃ (CH ₂) ₇ CO-	o-tolyl	C ₆ H ₄ CH ₃ -
oleyl (from oleic acid)	CH ₃ (CH ₂) ₇ CH=CH(CH ₂) ₇ CO-	tolylene (methylphenylene)	(CH ₃ C ₆ H ₄) ₂ =
oxalyl (from oxalic acid)	-OCCO-	o-tolylene	C ₆ H ₄ CH=
oxamido	H ₂ NCOCONH-	tosyl [(4-methylphenyl) sulfonyl]	4-CH ₃ C ₆ H ₄ SO ₂ -
oxo (keto)	O=	triazano	H ₂ NNHNNH-
palmityl (from palmitic acid)	CH ₃ (CH ₂) ₁₄ CO-	trimethylene	-(CH ₂) ₃ -
pelargonyl (from pelargonic acid)	CH ₃ (CH ₂) ₆ CO-	triphenylmethyl (trityl)	(C ₆ H ₅) ₃ C-
pentamethylene	-(CH ₂) ₅ -	tyrosyl (from tyrosine)	4-HOC ₆ H ₄ CH ₂ CH(NH ₂)CO-
pentyl	CH ₃ (CH ₂) ₄ -	ureido	H ₂ NCONH-
phenacyl	C ₆ H ₅ COCH ₂ -	valeryl (from valeric acid)	C ₄ H ₇ CO
phenacylidene	C ₆ H ₅ COCH=	valyl (from valine)	(CH ₃) ₂ CHCH(NH ₂)CO-
phenanthryl	(C ₁₂ H ₉)-	vinyl	CH ₂ =CH-
phenethyl	C ₆ H ₅ CH ₂ CH ₂ -	vinylidene	CH ₂ =C=
phenoxy	C ₆ H ₅ O-	xenyl (biphenyl)	C ₆ H ₅ C ₆ H ₅ -
phenyl	C ₆ H ₅ -	xyldino	(CH ₃) ₂ C ₆ H ₄ NH-
phenylene	-C ₆ H ₄ -	xylyl (dimethylphenyl)	(CH ₃) ₂ C ₆ H ₃ -
phenylenedioxy	-OC ₆ H ₄ O-	xylylene	-CH ₃ C ₆ H ₃ CH ₃ -
phosphino	H ₂ P-		